Balneological and Climatological Section.

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Dr. T. Fred Gardner, President of the Section, in the Chair.

The Influence of Calcareous (Hard) Drinking Water in Health and Disease.

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In estimating the various influences which combine to make up the elements of any particular climate it is reasonable to suppose that the drinking water of a locality may be a matter of considerable moment, and the subject of our discussion to-day is "hard water" wherever it may be found. But the water which most particularly concerns us is that which owes its hardness to the presence of chalk in solution.

A large number of different diseases have been attributed to the influence of chalky drinking water, but those more usually alleged are gout, rheumatism, calculus, constipation, biliousness, dyspepsia, eczema, goitre, and arterio-sclerosis.

In Favour of Baneful Influences.

(1) It is an undoubted fact that many persons when coming to visit or reside at Folkestone do suffer, at any rate at first, from some of the different conditions mentioned, though it remains to be proved that the hard drinking water, rather than other causes, is the reason of this. We shall return to this point later on.

(2) From a discussion held by this Section in 1907 on the "Influence of Climate in Gout, Rheumatism and Rheumatoid Arthritis," there followed as a main result the opinion that climate had a good deal more to do with the production of these diseases than water. There was a general agreement that warmth, an even temperature, dryness, free ventilation of the district, house construction,

[1] Provincial Meeting held at Folkestone.

the character and habits of the people, were all important matters. Dr. Buckley, who opened the discussion, suspected that the functional disorders of the liver common with people on first coming to the seaside might be the precursors of gout, &c. But these effects are acknowledged to be but temporary. Dr. Buckley, however, said that he was convinced that places where the water was hard and chalky were unfavourable to gout. He apparently based his opinion on the number of patients who go to Buxton for treatment from Folkestone and the neighbouring resorts. There is, however, quite a different explanation than the drinking water, of the gout from which these persons suffer. In the first place, most of these people are not natives of the seaside towns at all, but come to live in them on retirement from more active work. In all probability they acquired their gout long before taking up their residence here, and they as a rule probably drink very little or none of the local water supply in an unboiled condition, partaking usually of the aerated or bottled waters at their meals. Moreover, they unfortunately persist in the habits and diets which gave them their gout in the first instance, and which may be expected to bring forth more and more frequent exhibitions of their malady as life advances. Dr. Buckley would find very few, if any, of his patients who were total abstainers, or who imbibed as much as a pint daily of calcareous water.

(3) Sir Hermann Weber, in his "Climatology and Balneology," says: "It has been suggested that hard drinking water accounts for some of the indigestion and biliousness in visitors to health resorts on the chalk downs of the south coast of England." He goes on to say that "there is some evidence that the administration of calcium carbonate (and chalky mineral waters) tends to diminish the amount of uric acid excreted in the urine, and perhaps in some way to lessen its production." Again, he says: "Chalk does not appear in any way to increase the size of urinary concretions. Contrexéville water, which is harder than Bath water, owes most of its repute to its diuretic action." And: "It is possible the internal employment of calcareous waters might be useful in some cases of chronic and recurrent urticaria, chronic headache, &c., conditions which are associated with deficient coagulability of the blood."

(4) Nor if we turn to other authorities do we find them any more definite. Rumpf, for example, states that when much lime is taken with the food some of it remains stored up in the body, and may increase the tendency to calcareous deposits in the cardiovascular system of old people. Rumpf evidently considers this a disadvantage;

but on the other hand, if we refer to Sir Clifford Allbutt, we find him of opinion that hard drinking water plays no important part in the causation of arterio-sclerosis. Sir Clifford Allbutt merely regards calcification as a secondary event which does not enter into the process until the lesion is otherwise established. Then he says calcification may be some protection to a decaying vessel. In any case, if the degenerative process wants lime there is plenty to be had both in the body and in the food, without calling on the chalk in the water. In the arterio-sclerosis of high arterial pressures calcification is a late event.

(5) The Commission which was appointed (by the Home Department in 1851) to investigate the quality of water available for the supply of London, after taking evidence from a large number of medical men and chemists, reported, amongst other conclusions, as follows: "The only observations from which an interference of the lime in water in deranging the process of digestion and assimilation in susceptible constitutions has been conjecturally inferred, have been made upon water containing much sulphate of lime and magnesia, as the Brighton shallow well water or the hard selenitic water of the New Red Sandstone, and have no force when applied to the Thames and its kindred waters, as the earths exist in these principally in the form of carbonates." The objections, then, do not apply to Folkestone and chalky water.

(6) If we turn to books on materia medica we learn that lime salts given in medicinal doses only enter the circulation in very small quantities, and appear in the blood as phosphates. If merely a little enters in this way, how very small a proportion is presumably absorbed from drinking water. Is there any reason for considering it as otherwise than as a negligible quantity? Is there any evidence that hard water is useful in any of those conditions for which calcium salts are commonly prescribed with success? Are the diseases for which calcium salts are given rare in communities supplied with hard water? We find plenty of scope for prescribing calcium salts in Folkestone. The important part played by lime salts as a constituent of bones has suggested their use as a specific remedy in rickets, fractures and other diseases of these structures, and medicinal doses of calcium salts are given for these conditions. There is no evidence, however, that calcareous waters are of any service in this respect. Of other diseases for which calcium salts are given, the most prominent are menorrhagia, hæmophilia, purpura, hæmoptysis, and tendencies to capillary hæmorrhages in general, urticaria, pruritus, some forms of headache,

exophthalmic goitre, and scrofulous glands. It cannot be said that these diseases are rare or do not occur in the health resorts in question. But no medical man practising in these resorts would expect to obtain a curative effect from prescribing even large quantities of water from the main. Undoubtedly many women who live in the seaside towns of this district suffer more at their periods than they do elsewhere; but as amenorrhœa is also common, it is difficult to imagine that the water supply plays any rôle in the matter whatever.

(7) As regards goitre, quite a number of cases are treated annually at the Folkestone Hospital. It appears, however, that most of these cases come from the country districts outside the town away from the hard water supply. Goitre is more often associated with limestone districts. It is prevalent in some areas and absent in others where the conditions appear the same. Melted snow water is supposed commonly to exert more influence in the causation of this disease than any other waters, however hard.

(8) As regards the skin, Mitchell Bruce says that the action of calcium salts is desiccative and astringent. This, then, may have some bearing on the causation of eczema, a disease, however, which is uncommon here. There is no doubt that it is possible to more thoroughly cleanse the skin with soft water than with hard. Ladies who reside here mostly use distilled water for washing their hair, as they find that the local hard water causes their hair to become dry and brittle.

(9) Another interesting fact is that stated by Parkes in his work on Hygiene. He mentions that coachmen and grooms dislike hard drinking water for horses, and there is a consensus of opinion amongst them that the animals' coats suffer from its use, and become harsh and dry instead of sleek and glossy. Horses drink large quantities of water in an unboiled condition. This evidence, therefore, appears to be of an important character. Our patients, however, do not drink large quantities of unboiled hard water, so that this fact is somewhat discounted.

(10) If calcium salts do not act directly, can they act indirectly? The experiments of Dr. W. G. Little on the solubility of the various salts of uric acid at the temperature of the body, and in saline solutions, rather suggest the truth of this. He found that the addition of a small amount of sodium chloride—viz., ½ per cent.—to distilled water increased the solubility of calcium and magnesium bi-urates, but reduced that of sodium bi-urate to almost zero. Dr. Little also found that the addition of even small percentages of calcium salts to distilled water had the

effect of very much lessening its solvent action on sodium bi-urate. Dr. Little concluded from these experiments *in vitro* that the formation of deposits and tophi was largely helped by the presence of calcium salts. These experiments made in glass vessels cannot, however, be made to apply to the human economy and its drinking water; the amount of calcium salts imbibed in drinking water being very small compared with the amount of the same salts taken in food. Calcium salts are contained in milk, milk biscuits, milk puddings, cheese, the outer layer of seeds, such as the wholemeal of wheat and oats. Many varieties of wine, even the better qualities, and all the inferior qualities, and all malt liquors, contain calcium salts.

Considerations against Baneful Influence.

We see, then, that there is little that is convincing which can be said in favour of the view that chalky drinking water exerts a baneful influence in health or disease.

Now, having considered the evidence in favour of the view that chalky water is pernicious to the health, let us briefly review what can be stated on behalf of the opinion that such water is not noxious in its effects.

(1) We will begin with Parkes. He says in his book on Hygiene that calcium carbonate in drinking water does no harm.

(2) Hard water is less easily contaminated with organic matter than soft.

(3) As four-fifths of the Earth's surface is provided by Nature with hard water, it can hardly be supposed that Nature would have distributed water of this kind with so lavish a hand were it to have a very deleterious effect on mankind.

(4) The mortality in Great Britain of the towns supplied with hard water is rather lower than that of towns supplied with soft water. Without attributing the mortality in either case as due to the drinking water it is nevertheless an interesting fact, as it points to soft water having no great advantage over hard.

(5) Many of the mineral waters, such as those of Contrexéville, which are beneficial in gout contain considerable quantities of carbonate of lime. In fact, carbonate of lime is found in most of the waters at different spas, where gout, rheumatism, &c., are successfully treated. On the hypothesis of the noxiousness of calcareous water in gout, how, indeed, is to be explained the disappearance or diminution of tophi (chalk-stones) in persons undergoing cures at the various spas? If there is anything in this idea that calcareous water is injurious, we shall, forsooth, have to abandon altogether treatment by mineral waters.

(6) The upper and middle classes drink mostly bottled waters at their meals, or water that has been boiled, as in tea or coffee. Can it be said that these classes suffer less from gout, rheumatism, &c., than the lower classes? Has it ever been proved that the blood of persons habitually drinking hard water shows an increased coagulability as compared with the blood of persons drinking soft water? Has it been noticed that diseases due to increased coagulability, such as thrombus and embolism, are more prevalent at hard water places than at others? Do the lower classes suffer more in this way than the upper and middle classes? If calcium carbonate is provocative of gout, rheumatism, &c., how can that fact be reconciled with the microbic theory of these diseases? How can be harmonized causes so widely different?

(7) As regards calculus. The late Sir Benjamin Ward Richardson was strongly of opinion that hard water had no effect in the production of calculi, thus agreeing with Weber, and opposing the popular idea to the contrary. Recently Dr. Benjamin Moore, in an article on renal calculi, stated that lime should be withheld from oxalurics on the ground that it would be liable to cause oxalate of lime calculi to form in the urinary passages. Dr. Johnston-Lavis, however, in criticizing this thesis, argued that "no dietary can be planned which would reduce the calcium element so low as to be insufficient to combine with the few centigrammes excreted daily even by an advanced oxaluric." "Surely," he says, "if these few milligrammes of oxalic acid which are daily excreted are neutralized by the lime salts of our food, any amount of additional lime cannot do further harm." The problem with oxalurics is not to prevent the introduction of calcium salts, but the absorption of exogenous oxalic acid in foodstuffs. For it is from the perverted metabolism of carbohydrates that the endogenous oxalates are derived. Dr. Johnston-Lavis affirms that the prevention of the formation of calcium oxalate stones in the urinary passages by means of calcium starvation has been tried and has failed. The waters of Vittel, containing much calcareous matter, are taken by a large number of visitors suffering from oxaluria every year. The Vittel physicians inform us that almost without exception they find the diurnal amount of oxalates is markedly diminished or very frequently disappears, and that this result is apt to be permanent even though these people are constantly drinking Vittel water and living on a dietary in which lime-bearing food is not excluded. On the other hand, at the Section for Pharmacology and Therapeutics of the British Medical Association Meeting in July, 1910, Professor Hans Meyer, of Vienna, reported that it had recently been proved that oxalic acid poisoning was due to the withdrawal of the

calcium salts from the body. The cardiac depression, the irritability of the sympathetic nervous system, and the general toxic symptoms of oxalic acid poisoning could, he affirmed, be relieved by the administration of calcium salts. The late Sir John Simon, in giving evidence before the Commission on Water Supply, said there were many explanations of the alleged prevalence of stone in the bladder in Norfolk—amongst which Norfolk dumplings held a chief place! The assertions became current when Norfolk had a famous lithotomist. It was possible that his reputation, by attracting sufferers into temporary residence in the district, or perhaps his zeal in discovering cases of stone, may have given the district a fictitiously lithogenous character. Or was it something in the shape of the dumpling which suggested a likeness to a calculus?

(8) Again, it must be remembered that there is a large population living on chalky water, and if there were any very decided ill-effects on their health the fact would be notorious—and we should not be debating it to-day. But, on the contrary, there is evidence pointing to some advantage to the human economy from the ingestion of calcium salts. Dr. Arbour Stephens, in February last,[1] published an article in which he set forth the view that the lack of calcium salts in the food of troops on active service was a predisposing cause of enteric fever and dysentery. There is no doubt, too, but that hard water is far preferable to soft for growing children. Birds are notorious calcium eaters. It has never been suggested that they suffer in consequence, unless, indeed, it be the domestic hen—and then only when its diet has been undertaken by Dr. Chalmers Watson, or some other member of this Section.

Explanation of the Alleged Baneful Effects.

On what, then, rests the explanation of the baneful influences alleged to be due to hard water. It is said to cause constipation, but Weber says, if constipation occurs it is only necessary to drink *more* of this water in order to overcome the constipating tendency. Even if constipation is present the kidneys are stimulated, and owing to the increased stimulation the elimination of calcium salts is equally effected. The materia medica books tell us that lime salts, and especially chalk, act as depressants to the glands of the gastric mucous membrane, so that their prolonged administration might be supposed in some way to alter nutrition. But this statement alludes to medicinal doses of lime salts or chalk. And appetite, so far from being depressed is stimulated by sojourn in such places as Folkestone and its sister resorts. It may be

[1] *Hospital*, 1911, xlix, p. 557.

that this idea of the harmfulness of chalk first arose from the mistaken notion that tophi (so-called chalk-stones) were really composed of chalk instead of urate of soda, to which chalk has no relation, being as different as chalk from cheese. Therefore it is impossible that this popular idea can have any foundation in fact. It is, however, in the so-called "seaside biliousness" that the real origin of the fallacy can be found. Nor is this biliousness to be wondered at. First, consider for a moment how completely visitors to the seaside change their habits. Consider the stimulation of appetite due to the change of air and environment, the increased tissue change, and the augmentation in the amount of exercise—all tending to cause an increased amount of auto-intoxicative material to enter the blood.

When these facts are taken into consideration, need one feel any surprise that the excretory organs at first fail to keep pace with the extra work thrown on them, fail, as it were, to keep the balance, and that temporary biliousness results from these causes?

Are we, then, to attribute the ill-effects which sometimes seem to synchronize with a visit to Folkestone to our hard water? Let us beware of the *post hoc ergo propter hoc* fallacy. It has been shown that there may be a variety of causes contributory to an attack of seaside biliousness, and other of the diseases alleged to be due to hard water In all probability the hard water does not enter into their causation at all. It may be pointed out that the effects sometimes attendant on a visit to the sea occur equally in those who drink the hard water and in those who do not, a fact which indicates a cause other than the water for these illnesses.

In conclusion, then, we may claim to have shown that there is no evidence that calcareous waters do any harm in either health or disease, and that the popular notion to the contrary has no rational basis in fact.

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DISCUSSION.

Dr. PERNET considered that calcareous water taken internally was not productive of eczema. He had seen a very large number of cases of eczema, and they came from many places with water supplies of various kinds. As to the local effects of calcareous and hard water on eczema, there was no doubt that they were bad. Again, the local use of calcareous and hard water might in some skins lead to an eczematous-looking dermatitis. He was of opinion that at the seaside climatic conditions were important, with other factors, in producing eczema and making it continue when once started. On the other hand, he had seen cases of eczema benefited by a sojourn at the seaside, but this was certainly not the rule.

Dr. BAGSHAWE (St. Leonards-on-Sea) wished to inquire as to the composition of Folkestone water. Was the hardness due to calcium carbonate alone or to sulphates or other mineral coming from the strata below the chalk? Calculus is found, by long hospital experience, to be infrequent at Hastings, in striking contrast to that at Cambridge, where the museum contains an enormous number of stones, in accord with the hospital experience. Here the water is from beneath the chalk. There are no chalk or carboniferous rocks within ten miles of Hastings, and the water is not hard except from the presence of an irregular quantity of iron, dealt with by magnetic filtration. He believed that the tendency to constipation among newcomers was common to all seaside places, and was probably due to the fresh surroundings and mode of life.

Dr. W. J. TYSON (Folkestone) said that whether the title of the paper was chosen by design or arose by accident, the result was a happy one, as Folkestone was well supplied with hard water. He thought that there was little doubt that such troubles as mild chronic rheumatism, certain skin diseases, biliousness and perhaps the anæmia of young people, were more common at the seaside than elsewhere, but this seemed to him to be due not to the presence of hard water, but to the climate, for the hard water found in inland towns did not appear to be a factor in the causation of the aforementioned diseases. From an economic and cosmetic point of view soft water was preferable to hard, for the latter often caused considerable expense to the householder from the furring of pipes, &c., and for washing purposes more soap was required.

Dr. CLIPPINGDALE recited his study of the Chiltern Hills, where he had found that the process used for softening water, while it had diminished the tendency to calculus, had increased the tendency to goitre.

Dr. LENNOX WAINWRIGHT (Folkestone) maintained that there were three factors to be considered in dealing with the question—viz., the diathesis of the individual, the climatic conditions, and the nature of the water supply.

Many people came to Folkestone after leading strenuous lives in the East and elsewhere, and were in a pathological condition of health. Such patients required individual treatment in the matter of water, just as much as in the matter of diet. Hard water had the advantage that it was free from contamination, whilst distilled and softened waters were almost impossible in town supplies. Chalk might be removed, but lead and disease might then be carried. Constipation was common in sailors who drank condensed water, and it could not in this case be ascribed to chalky water.

Dr. LEONARD WILLIAMS was of opinion that the alleged influence of calcium salts in drinking water could not bear examination. In the formation of calculi it was the acids, oxalic and uric, which were really responsible, and not the calcium base. It was impossible to get rid of all the calcium even if one wanted to. The patient would die of osteo-malacia. The consideration of osteo-malacia and rickets showed clearly that the question was more one of the activity of the internal secretory glands, the ovaries, the thyroid, and others.

Mr. BATEMAN (Folkestone) said that Folkestone water was derived from deep wells in the chalk, and that, on analysis, he had found its composition (expressed in grains per gallon) to be as follows:—

Chlorides	1·89
Nitrogen in nitrates and nitrites	0·25
Free ammonia	Trace only
Albuminoid	0·0008
Oxygen absorbed in 15 minutes	Trace only
,, ,, in 4 hours	0·022
Hardness (total)	18·7
,, (permanent)	2·9
Total solid	23·66

He pointed out that the amount of chalk taken in one pint of water would be about 2½ gr. to 3 gr., when drunk unboiled. If boiled, the amount would be about 1½ gr., which was not sufficient to be considered deleterious in any way.

Dr. A. F. STREET (Westgate-on-Sea) said he agreed with the views so clearly expressed by Dr. Lewis. He maintained that if chalk-containing water could produce the effects sometimes attributed to it, those effects could hardly fail to be notorious; and that physicians, who had practised for many years among populations using water drawn from wells in the chalk could not fail to be familiar with them. It was almost impossible to believe that such evil effects could occur and yet remain unknown to them; surely the weight of evidence had proved that this was not so. Where a prejudice against the use of chalk-borne water existed, he believed it to be due either to the common lay error that the so-called "chalk-stones" contained chalk, or to the ill-founded medical presumption that gout or rheumatism, or both, must be prejudicially influenced thereby.